

A SYSTEM FOR ASSISTING THE REGENERATION OF DEPOLLUTION  
MEANS FOR A MOTOR VEHICLE ENGINE

The present invention relates to a system for  
assisting the regeneration of depollution means  
5 integrated in an exhaust line of a motor vehicle diesel  
engine.

More particularly, the invention relates to such a  
system in which the engine is associated with a  
turbocharger and with common manifold or "rail" feed  
10 means for injecting fuel into the cylinders of the  
engine, using at least one post-injection operation, and  
adapted, at constant torque, to implement at least two  
regeneration strategies at a first level and at a second  
level, depending on different engine operation control  
15 parameters, in order to obtain different temperature  
levels in the exhaust line, the temperature level  
corresponding to the second level strategy being higher  
than that corresponding to the first level strategy.

When regenerating depollution means, such as a  
20 particle filter, an oxidation catalyst that has been  
poisoned by sulfur, a NOx trap that needs to be  
desulfized, or a SOx trap, it is necessary to raise the  
temperature of the engine exhaust gas considerably in  
order to obtain regeneration that is rapid, so as to  
25 minimize the overconsumption of fuel that is associated  
with such regeneration.

Unfortunately, this requires a very considerable  
increase in the temperature of the exhaust line and  
consequently in the temperature of the elements  
30 integrated therein.

Some strategies also rely on using the conversion of  
unburned hydrocarbons coming from the combustion in the  
engine, by making use of catalyst-forming means for the  
purpose of further raising the temperature level in the  
35 exhaust line.

However, temperature levels that are too high can lead to breakage, e.g. of the turbine portion of the turbocharger.

It is therefore necessary to have good control over  
5 the temperature levels involved during regeneration.

The object of the invention is thus to solve these problems.

To this end, the invention provides a system for assisting the regeneration of depollution means  
10 integrated in an exhaust line of a motor vehicle diesel engine, in which the engine is associated with a turbocharger and with common rail feed means for injecting fuel into the cylinders of the engine in at least one post-injection, and adapted to implement, at  
15 constant torque, at least two regeneration strategies, at a first level and at a second level, depending on different engine operation control parameters, in order to obtain different temperature levels in the exhaust line, the temperature level corresponding to the second  
20 level strategy being higher than the temperature level corresponding to the first level, the system being characterized in that it includes acquisition means for acquiring the temperature level in the exhaust line, comparator means for comparing said temperature level  
25 with a safety threshold value for the turbine of the turbocharger so that in the event of said threshold value being exceeded while applying the second level strategy, the feed means are controlled so as to regulate at least one of the engine operation control parameters  
30 progressively so as to reduce the temperature level in the exhaust line, and if said temperature level does not drop below the threshold value at the end of a predetermined first time period, the feed means are controlled to switch over to the first level strategy,  
35 and if the temperature level in the exhaust line still does not drop below the safety threshold value at the end

of a second time period, the feed means are controlled to stop the regeneration strategy.

According to other characteristics:

- the feed means are adapted to implement two successive post-injections;
- during regulation, the feed means are adapted to reduce progressively the flow rate of fuel during the second post-injection;
- the feed means are adapted to reduce the flow rate of the second post-injection by using a correction factor lying in the range 0 to 1 and determined on the basis of the difference between the temperature level acquired from the exhaust line and the safety threshold value;
- the correction factor is determined by a PI type regulator having non-linear gain;
- the temperature level acquisition means comprise at least one temperature sensor;
- the safety threshold value is calibratable;
- the depollution means comprise a particle filter;
- the depollution means comprise a NOx trap;
- the depollution means comprise an oxidation catalyst;
- the depollution means comprise a SOx trap;
- the fuel includes an additive for being deposited, together with the particles with which it is mixed, on the depollution means in order to facilitate regeneration thereof; and
- the fuel includes an additive forming a NOx trap.

The invention can be better understood on reading the following description given purely by way of example and made with reference to the accompanying drawing, in which:

- Figure 1 is a block diagram showing the structure of a system of the invention for assisting regeneration; and

- Figure 2 shows the operation of control means involved in constituting such a system for assisting regeneration.

Figure 1 shows a system, given overall reference 1, for assisting the regeneration of depollution means generally associated with oxidation catalyst-forming means, given overall reference 2, that are integrated in an exhaust line, given overall reference 3, of a motor vehicle diesel engine 4.

The catalyst-forming means are placed upstream from the depollution means.

The engine is associated with a turbocharger having a turbine portion 5 disposed in the exhaust line and a compressor portion 6 disposed upstream from the engine.

By way of example, the depollution means may comprise a particle filter, a NOx trap, an oxidation catalyst, a SOx trap, etc. . . . .

It should also be observed that, in conventional manner, the fuel may include an additive for becoming deposited, together with the particles of which it is mixed, on the depollution means in order to facilitate regeneration thereof by lowering the combustion temperature of soot trapped thereon.

In conventional manner, the additive is present in the particles after the fuel with additive has been burnt in the engine.

An additive constituting a NOx trap may also be envisaged.

The engine is also associated with common rail feed means for injecting fuel into the cylinders of the engine using at least one post-injection.

These means are given overall reference 7 in this figure and they are associated with control means, given overall reference 8, serving, at constant torque, to implement at least two regeneration strategies, at a first level and at a second level, depending on different engine operation control parameters, so as to obtain

different temperature levels in the exhaust line, with the temperature level corresponding to the second level strategy being higher than the temperature level corresponding to the first level strategy.

5        This is then done by modifying the engine operation control parameters, such as its admission air, by regulating the admission butterfly valve to the engine, by regulating the setpoint pressure for the turbocharger, or by regulating the quantity of fuel that is injected  
10       into the engine, e.g. during the post-injections, in conventional manner.

Such depollution means can be regenerated by making use of multiple injections into the cylinders of the engine, in particular during their expansion stages.

15       In order to limit the temperature level in the exhaust line during regeneration, the control means continuously monitor the temperature therein, in order to adapt the characteristics of the various injections (flow rate, start of injection, etc. ...) so as to reduce the  
20       temperature level in the exhaust line when it is too high.

The system includes acquisition means for acquiring the temperature level in the exhaust line, given overall reference 9 in the figure, comparator means for comparing  
25       said temperature level with a safety threshold level for the turbocharger compressor, constituted by the control means 8, so that in the event of said threshold value being exceeded while the second level strategy is being applied, designated by overall reference 10, to control  
30       the feed means 7 in such a manner as to regulate progressively at least one of the engine operation control parameters so as to reduce the temperature level in the exhaust line, and if said level does not come back below the threshold value at the end of a first  
35       predetermined time period, to control the feed means to switch over to the first level strategy, given overall reference 11, and if the temperature level in the exhaust

line still does not come back below the security threshold value at the end of a second predetermined time period, to control the feed means to stop implementing the regeneration strategy.

5       The means 9 for acquiring the temperature level in the exhaust line may comprise a temperature sensor placed therein, e.g. close to the turbine portion of the turbocharger.

10       Figure 2 shows how regulation is performed, and it can be seen that a comparator, given overall reference 12, receives as one of its inputs the safety threshold *safe.th* from the turbocharger turbine, and the temperature level *TL* in the exhaust line, acquired in the manner described above.

15       The output from the comparator 12 is connected to a PI type regulator having non-linear gain, given overall reference 13, that is adapted to deliver correction information to a corrector 14 for progressively reducing the fuel flow rate in a second post-injection in the event that the feed means 7 are adapted to enable two successive post-injections.

20       It can thus be understood that under such circumstances the feed means 7 are adapted to reduce the flow rate of the second post-injection by using a correction factor lying in the range 0 to 1 and determined on the basis of the difference between the temperature level *TL* in the exhaust line and the safety threshold *safe.th*.

25       Naturally, the safety threshold value can be calibratable.

30       It can thus be understood that the purpose of the system is to limit the temperature level in the exhaust line so as to preserve the integrity of the turbocharger turbine.

35       Excessive temperature peaks can then occur only when the regeneration assistance system is operating at the second level.

By comparing the instantaneously measured temperature with a threshold, it is possible to determine whether or not a critical temperature has been exceeded.

5       Thereafter, as a function of the difference relative to the threshold, the regeneration assistance strategy (flow rates and phase offsets for the various injections) is modified so as to reduce the temperature while continuing to deliver constant torque, e.g. by reducing the post-injection flow rate.

10       In the example described, the regeneration strategy uses multiple injections, and in particular it uses two post-injections. Calibration can then be performed for the second post-injection.

15       The quantity of fuel involved in post-injection is corrected so long as the temperature level in the exhaust line remains above the safety threshold. If in spite of reducing the quantities injected the temperature level does not drop back below the threshold at the end of the first time period, then the system is forced to switch  
20 over to the first level strategy.

      If even after switching over to said first level strategy the temperature level continues to remain excessive for a predetermined time period, then regeneration is switched off.

25       Thus, if the temperature level  $TL_{line}$  in the line as measured by the temperature in the line exceeds a calibratable threshold  $T_{max}$ , then the second post-injection flow rate is reduced progressively by being multiplied by a correction factor,  $K_{turbine}$ , lying in the  
30 range 0 to 1, given by a PI type regulator with non-linear gain as a function of the temperature difference between the measured value and the safety value for the turbine.

      A timer  $t_{st}$  is then triggered. At the end of a  
35 calibratable time  $t_{safe.turbine}$ , the regeneration system is forced to the first level during a calibratable minimum time  $t_{level1.turbine}$ . If at the end of this

time  $t_{level1.turbine}$ , the temperature level has still not dropped below the safety threshold  $T_{max}$ , then regeneration is stopped.

5 It will be understood that such a system enables operating safety to be ensured for the turbine of the turbocharger.

Naturally, other embodiments could be envisaged.

10 Thus, for example, the depollution means and the oxidation catalyst-forming means could be integrated in a single element, in particular on a common substrate.

By way of example, a particle filter integrating the oxidation function could be envisaged.

15 Similarly, a NOx trap integrating such an oxidation function could also be envisaged, whether or not an additive is used.

This oxidation function and/or NOx trap can be implemented, for example, by means of an additive mixed in with the fuel.

20 Finally, the depollution means may also include an oxidation catalyst or SOx trap.